Project Fact Sheet

Monitoring of Geothermal Heat Pump Installations and Analysis of Monitoring Data

GOALS

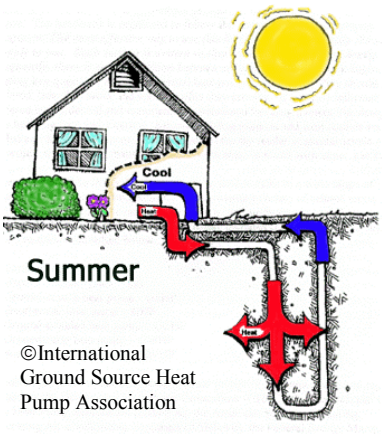
- Monitor system performance at "problem" geothermal heat pump (GHP) sites in two electricity service territories: SMUD and Truckee Donner PUD.
- Identify potential remediation work on buildings and implement cost-effective remediation measures.
- Update GHP economic projections, including overall GHP cost-effectiveness, GHP desuperheating, and dedicated GHP water heating.

PROJECT DESCRIPTION

Geothermal (or "ground source") heat pumps (GHP's) generally utilize a buried "loop" of tubing to exchange heat with soil, rather than the refrigerant-to-air heat exchangers used by conventional air-source heat pumps (ASHP's). GHP's typically have higher operating efficiencies than ASHP's due to milder condensing and evaporating temperatures, elimination of defrost cycles, little or no need for supplemental resistance heating during cold weather, and the use of desuperheaters to heat domestic hot water.

This project is a follow-up project to the *SMUD/TDPUD GHP Monitoring & Evaluation Project*, completed in 1998. It continues and expands the efforts to monitor and evaluate geothermal heat pump sites in the Sacramento and Truckee service districts. The current project involved conducting "whole house performance" audits and remediation efforts. Eleven of the previous sites and nine new sites were monitored, for a total of 20 sites and 27 heat pumps (some sites with multiple units).

Of these 20 sites, eight "problem" sites were identified as a result of customer reports of one or more of the following issues: (1) high energy use, (2) inability to maintain indoor comfort, (3) insufficient heating and/or cooling capacity, and (4) unreliable system operation. These eight houses (13 GHPs) received "whole house performance" audits to explore "whole house" performance. Factors such as heat pump performance, building envelope deficiencies, HVAC system airflow, air distribution system leakage, system controls, and occupant interaction with HVAC controls were studied. These eight sites had "whole house" diagnostic testing performed to determine what remediation options are available. Viable measures were implemented, monitoring continued, and the benefits of remediation were qualified. These remediation efforts define the central focus of this PIER project.



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BENEFITS TO CALIFORNIA

Improving the performance of geothermal heat pumps in buildings is an important step to their increased use in California. The use of geothermal heat pumps provides economic, environmental, health, and safety benefits to Californians. By reducing the need for fossil fuel combustion, geothermal heat pumps improve California's air quality. Improved air quality, in turn, reduces public health risks. Where a GHP is used in place of combustion-based heating, risks of fire, explosion and carbon monoxide poisoning are eliminated. In addition, since GHPs have no outside condensing units, ambient noise levels are reduced.

Lastly, geothermal heat pumps deliver substantial demand and energy savings. Summer demand savings are at least 25%, compared to a conventional SEER 10 air conditioners or air source heat pumps. Savings approach 50% compared to older inefficient units. Winter energy savings are about 50% compared to a new conventional heat pump but are small compared to natural gas use.

FUNDING AMOUNT

Match Share: $386,347
CEC Share: $168,292
Total Cost: $554,639

PROJECT STATUS

Completed.
See results below.

PROJECT RESULTS

Remediation Efforts: At the five Truckee sites, monitoring data demonstrated a clear benefit from the remediation work at three of the sites. At two of the three, simple paybacks of around 20 years were projected. At the third (the highest per ft^2 energy user), a favorable payback of around seven years was projected. All five Truckee sites had favorable comments regarding the remediation work.

Performance Projections and GHP Economics: Performance projections indicate annual savings of approximately $750 for the Truckee area. A combination of efficient GHP performance and favorable gas/electric utility rates contributes to the savings level. In the SMUD territory, "typical" GHP customers can expect annual savings of about $290 per year. Savings were only about $150, when compared to a gas furnace/air conditioner.

Typical demand savings in the SMUD territory were about 20%, compared to standard 10 SEER cooling equipment. In the Truckee area winter peak period, maximum projected demand was expected to increase from 0.3 to 2.5 kW, relative to a standard gas furnace.

A desuperheater model, based on field-monitored performance, indicates a 5 to 9 year projected simple payback period. This is very favorable when compared to electric water heating, which typically has a payback ranging from 12 to 24 years. Dedicated geothermal water heaters (DGWH) were also found to generate favorable economics relative to electric water heating, with a payback of 8-9 years.

Assuming a customer "10 year simple payback criteria", GHP's are currently viable in Truckee Donner service area. In the SMUD territory, GHP's are viable compared to air-source heat pumps, but are not cost-effective compared to the more common furnace/air conditioner installation. These conclusions are sensitive to the balance between gas and electric rates.

Several key energy efficiency measures were analyzed to determine if they provided a cost-effective means of reducing the GHP equipment sizing in new construction. For Truckee, the load (and corresponding capacity) reduction for both tight ducts and a tight envelope were more cost-effective than additional GHP capacity. Likewise for Sacramento, tight ducts and Low-E^2 high-performance windows demonstrated favorable economics. For retrofit work these measures are much more costly to complete, supporting the hypothesis that every effort should be made to incorporate energy-efficiency during design and construction to minimize the installed GHP system capacity.

FOR MORE INFORMATION

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